Loc. Sandakan, N. Borneo. A single specimen obtained by Mr. Douglas Cator.

This species may be at once recognized from *S. sumatranus* (= *S. Beccarii*, Thorell, Ann. Mus. Genov. xviii. p. 25, 1882) from Sumatra and from *S. javanus* (Thorell, *loc. cit.* p. 30) from Java by having the upper surface of the trunk smooth and not densely granular.

XXX.—*A Contribution to the Osteology of the Mesozoic Amioid Fishes* Caturus *and* Osteorachis. By A. Smith Woodward, F.L.S.

[Plates VIII.–XI.]

The well-known Leeds Collection from the Oxford Clay of Peterborough has already furnished many important illustrations of the osteology of the Mesozoic fishes. Several more examples, however, still remain to be utilized, and the present contribution to our knowledge of the early Amioids is chiefly based on a fine series of new specimens of *Caturus* and one of *Osteorachis* in this collection. The description of these is followed by a brief note on a unique example of the Liassic *Osteorachis macrocephalus*, which has hitherto been imperfectly known, but can now be elucidated with greater precision. The whole series of observations shows more clearly than ever how extraordinarily similar are certain Mesozoic rhombic-scaled notochordal genera to the existing *Amia*, even in some of the minute features of osteology.

I.—*Caturus*, sp. ind., from the Oxford Clay of Northamptonshire and Wiltshire.

There is still so much uncertainty as to the distinction of the various species of *Caturus* known even by whole skeletons that it seems inadvisable at present to give any specific names to the comparatively fragmentary examples of this genus from the English Oxford Clay. Their great interest consists not in their precise systematic relationships, but in their naturally dissected condition, which adds so much to our knowledge of the osteology of the fish. It must suffice to remark that most of the specimens belong to a species closely related to, if not identical with, the typical *Caturus furcatus* of the Bavarian Lithographic Stone; while some have comparatively larger and fewer teeth. All these fossils have now been acquired

by the British Museum, and the numbers in brackets always refer to the Register of the Department of Geology.

Cranium.

The chondrocranium exhibits extensive ossifications, but was not sufficiently resistant to withstand complete collapse in the soft clay. The basioccipital is deeply excavated on its posterior face by a conical fossa for the notochord, and the inferior aspect of the bone (no. P. 6901) is marked by a longitudinal groove, though this is not covered by the parasphenoid and there is apparently no basicranial canal. There are robust ossifications in the postfrontal and prefrontal (lateral ethmoidal) regions, but cartilage must have persisted in the mesethmoid, which can only have been small. In the lateral wall of the cranium, immediately in front of the postfrontal, there appears a very large ossification, longer than deep, which is probably to be identified with the alisphenoid (no. P. 6906); a smaller, nearly quadrate ossification adjoins this behind, and seems to correspond with the pro-otic of *Amia* (seen in same specimen); and a third bone, occurring still further back, quite at the angle of the occiput (seen in no. P. 6901), agrees well with the opisthotic of the same genus. The latter element is shown to be pierced by a large oval foramen, evidently for the exit of the vagus nerve. A great parasphenoid sheaths most of the base of the cranium, forked posteriorly and not quite reaching the occiput, comparatively broad in advance of the basipterygoid processes, and provided in this region with an elongated lenticular patch of very minute teeth. Each basipterygoid process was evidently much elongated, reaching the postfrontal above. The parasphenoid extends as far forwards as the prefrontal region, there expanding a little and meeting the pair of large vomers. These two bones meet throughout their length, but are not fused in the median line, and each is about three times as long as broad, bearing a few teeth only at its anterior end. The bases of about four of these vomerine teeth are shown in no. P. 6901. The membrane-bones of the cranial roof form a continuous flattened shield, and in large individuals its principal elements sometimes appear to be fused together. The occipital border is straight (Pl. VIII. fig. 1, *occ.*), formed, as usual, by the parietals and squamosals. The parietals (*pa.*) are shown, in nos. 29049, P. 6908 *c*, to be relatively small, with the wavy suture between them not quite mesially placed, and each sends forwards at its outer margin a long pointed process inter-

digitating with the frontal (seen also in no. P. 6904). The squamosals (*sq.*), though considerably crushed and fractured in the specimen figured, are observed to be much larger than the parietals and extend further forwards. The frontals (*fr.*) are relatively enormous, uniting in an irregular, often interdigitating mesial suture, the outer surface especially rugose in their anterior half, and irregularly marked with rows of pittings which appear to be connected with the sensory canal-system. It is not quite clear whether the ossified postfrontal appears behind, but the prefrontal is exposed in front (Pl. VIII. fig. 2, *pr.f.*), and between these two elements the frontal is bordered by an irregular series of supraorbital plates (Pl. VIII. figs. 1, 2, *sp.o.*), which are continued extensively down upon the cheek as a patch of antero-posteriorly elongated tesseræ (Pl. VIII. fig. 2, *t.*). This arrangement can also be seen in the typical species, *Caturus furcatus*, from the Bavarian Lithographic Stone (*e. g.* specimen in Brit. Mus., no. P. 908). The nasal bones (Pl. VIII. figs. 1, 2, *na.*, and Pl. IX. figs. 4, 4 *a*) are small, antero-posteriorly elongated, externally tuberculated, and exhibit the usual little lateral process in the anterior half of their outer margin. One specimen (Pl. VIII. fig. 2) suggests that a very small, transversely elongated, bilaterally symmetrical membrane-bone (*x*) also covered the rostral end of the mesethmoid; but this little element is crushed and fractured.

Facial Bones, Jaws, and Hyoid Apparatus.

The cheek is completely covered with thin plates. Immediately in front of the preoperculum are two very large plates of the suborbital (postorbital) series (Pl. VIII. fig. 3, *s.o.*). Two circumorbitals (*c.o.*), the lower broad and the upper narrow, separate these from the orbit, and there is a small series beneath the eye. There is also at least one antorbital plate (Pl. VIII. fig, 3, *a.o.*). The supraorbitals have already been described, and it only remains to add that portions of an ossified sclerotic can often be observed within the cavity of the orbit (Pl. VIII. fig. 3, *scl.*). The hyomandibular (Pl. IX. fig. 1, *hm.*) is large, much laterally compressed and expanded, with a considerable process (*p.*) for the support of the operculum. The quadrate (Pl. IX. fig. 1, *qu.*) is triangular, meeting the front half of the lower margin of the hyomandibular, and doubtless bordered behind by an ossified symplectic, which has not yet been seen. The articular head of the quadrate is especially robust, with a concave facette for the articulation of the mandible. The

pterygoid bones are too imperfect for description; but the entopterygoid is clearly thin, expanded, and laminar, with fine granulations on its oral face (Pl. IX. fig. 1 *a*, *enpt.*). Another stouter bone, which is deepened in front and bears a series of large teeth on its outer inferior margin, may be the ectopterygoid (Pl. IX. fig. 1, *ecpt.*). The palatine on its inner face appears as a small lamina of bone below the entopterygoid, and on its oral margin, which is apposed to the maxilla, there is a single series of large teeth (Pl. VIII. fig. 4 *a*, *pl.*); but viewed from without (Pl. VIII. fig. 4, *pl.*) this element is shown to be in reality of robust proportions, interposed as usual between the maxilla and prefrontal. The maxilla (Pl. VIII. figs. 3, 4, *mx.*) is much elongated, somewhat deepened behind, thickened in front, and bearing a long inwardly and anteriorly directed process immediately in advance of its palatine articulation. Its oral border forms an irregular concave arch, and bears a single series of teeth, which are smallest behind; the hinder portion of its upper border exhibits a facette (Pl. VIII. fig. 4, *f.*), which is overlapped by an elongated supramaxillary plate (Pl. VIII. fig. 3, *s.mx.*). The premaxilla (Pl. VIII. fig. 3, *pmx.*) exhibits an extended oral border, with a series of teeth larger than those of the maxilla; the nature and limits of its ascending process cannot be satisfactorily observed. The mandible (Pl. VIII. fig. 3; Pl. IX. figs. 1, 1 *a*) is very narrow at the symphysis, has a nearly straight inferior border, and gradually rises into a high coronoid region near its hinder end; it comprises four, perhaps five, distinct elements. The long dentary (Pl. VIII. fig. 3; Pl. IX. figs. 1, 1 *a*, *d*) occupies the greater portion of the outer aspect, meets its fellow of the opposite side at the symphysis, rises behind into the coronoid, and bears a single series of relatively large teeth. The splenial (Pl. IX. fig. 1 *a*, *spl.*) extends about as far as the dentary on the inner side of the ramus, and is much thickened where it enters the symphysis; its teeth are all very small, and for at least the anterior half of the bone they are arranged in a single series, while beyond they appear to be clustered. The angular element (*ag.*) is large, forming the greater part of the coronoid region, and immediately above it is an elongated coronoid bone (*cor.*) completing the elevation. The articular (*ar.*) exhibits a convex facette at the extreme hinder end of the mandibular ramus, but whether or not this element is fused with the angular is as yet undetermined. The epihyal (Pl. IX. figs. 1, 1 *a*, *ep.h.*) is small and triangular in form, with a robust facette near the hinder end of its upturned margin; its extreme length is scarcely more

than one third that of the ceratohyal (*c.hy.*), which shows no evidence of twisting, is twice as deep behind as in front, and is thickened at the anterior extremity for articulation with the hypohyal. The hypohyal (Pl. IX. fig. 2) is especially robust, narrowed and turned inwards at its anterior end.

Opercular, Branchiostegal, and Branchial Apparatus.

The gill-covers form a complete series of plates. The preoperculum is large and much expanded at its angle, where the exposed surface is rugose, and one specimen (Pl. IX. fig. 1, *p.op.*) exhibits a facette-like excavation of its lower extremity, as if it articulated with the inferior prominence at the hinder end of the mandible. The operculum, subopercular, and interopercular are large, and do not merit special description; the suboperculum has a large ascending process at its antero-superior angle (no. 29049). The branchiostegal rays (Pl. VIII. fig. 3, *br.*), slightly over twenty in number, are all broad, but the uppermost especially so, and their free ends are sometimes (*e. g.* no. P. 6904) shown to be pectinated. In advance of the branchiostegal rays there is a very large gular plate (Pl. VIII. fig. 3, *gu.*) extending between the mandibular rami for more than half their length. A detached example (Pl. IX. fig. 3), wanting its hinder portion, exhibits a slight longitudinal median keel in its anterior half.

The branchial arches are only known by fragments (Pl. VIII. fig. 5), which display the ordinary channelled bone, mixed with small tooth-like gill-rakers (*g.r.*) and slender calcified gill-filaments (*fil.*). One specimen (Pl. IX. fig. 1, *g.r.*) shows that some of the gill-rakers at least were fixed on the edge of little plates of bone, resembling those on the gill-arches of the modern *Amia*.

Axial Skeleton of Trunk.

The examples of *Caturus* from the Oxford Clay of Peterborough do not afford any additional information as to the axial skeleton of the trunk. The complete skeletons from the Lithographic Stone of Bavaria and France have already proved that the notochord was persistent and that the ossifications in its sheath were confined to separate hypocentra and pleurocentra. A detached abdominal hypocentrum from Peterborough, however, shown from three points of view in Pl. IX. figs. 5, 5 *a*, 5 *b*, is interesting for comparison, and bears the characteristic small lateral processes for the support of the ribs. Whether any vertebral element was fused with the basioccipital remains unknown.

Appendicular Skeleton.

Resting upon the rim of chondrocranium which projects behind the occipital border of the cranial shield is a single pair of large supratemporal plates, each tapering towards the middle line, and from beneath this shield there emerges behind a pair of still larger post-temporal plates marked with small pittings, apparently of the sensory canal-system, near its outer border (Brit. Mus. no. P. 6908 *a*). There is nothing worthy of remark in the imperfectly known pectoral arch which these elements support, and the number of the pectoral basals still remains to be discovered. There are, however, several good portions of pectoral fins, and when viewed from below these exhibit the slightly lobate form of the appendage (*e. g.* no. P. 6908 *c*). The slender anterior fulcra seem to have fused with the foremost ray, and this is hence remarkably stout; at its upper end it exhibits a very large concave articular facette. The hindermost rays of the fin are short and excessively delicate. The pelvic bones are separate, contracted mesially, and expanded at each end, and the small pelvic fin is fringed with conspicuous slender biserial fulcra. The fulcra on the median fins are also large, slender, and biserial, and the tips of a few of the gradually lengthening anterior rays of these fins are successively lost in the fulcral series (no. P. 6909). At the base of these fins, it may be added, the few fulcral scales are simple, not subdivided into two halves.

Squamation.

The scales are very thin over the whole of the trunk and only appear thickened on the atrophied upper caudal lobe (no. P. 6909). Their exposed face is distinctly rhombic and often punctate or partly striated, but chiefly marked by the concentric lines of growth.

[To be continued.]

XXXI.—*On Lepidoptera Heterocera from China, Japan, and Corea.* By John Henry Leech, B.A., F.L.S., F.Z.S., &c.

[Continued from p. 235.]

Genus Rumia.

(Dup.; Hampson, Fauna Brit. Ind., Moths, iii. p. 183 (1895).)

Rumia tridentifera.

Rumia tridentifera, Moore, Lep. Atk. p. 30 (1887); Hampson, Fauna Brit. Ind., Moths, iii. p. 184 (1895).

Five male specimens and one female received from Ta-chien-lu, Pu-tsu-fong, and How-kow: June, July, and August.